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EMBEDDED SYSTEMS... CREATING TOMORROW'S INNOVATIONS

AGNÈS GABRIELLI

The high-potential embedded systems sector is central to future industrial innovation. Its enormous economic potential opens up exciting new prospects for research, jobs and training. However the sector's fundamentals are changing dramatically as environmental aspects are taken into account. Many traditional trades are rapidly becoming greener and new trades are emerging in the eco-construction field. Driven by factors including the Grenelle environmental protocol, ambitious legislation and regulations, incentivizing fiscal measures, etc., construction has become sustainable, energy efficient and even energy positive!

ZOE preview – © Renault Communication

Embedded systems may be the 'hidden' face of information technology, but they are of crucial importance. Largely unknown in the public consciousness, they may be defined as a series of electronic chips running software dedicated to carrying out specific tasks and designed to be fully integrated into other sub-assemblies. These days, they're everywhere! You'll find them in transportation (automobiles, aircraft, etc.), electrical and electronic products (cameras, GPS units, etc.), process controls (robotics, etc.), telecommunications and security (smart cards, etc.), healthcare, sustainable development applications, toys and consumer goods.

Dynamic growth

This industry is only around twenty years old, and it continues to flourish despite the global crisis. According to a report published in 2011[1], the embedded systems market is growing very quickly, with more than 1.8 billion units sold worldwide, generating revenue in excess of $1,000 billion. The sector is expected to have doubled by 2015 to almost 4 billion units and revenue generation of more than $2,000 billion. On the basis of this forecast, 14.5 billion microprocessors will be required for use in embedded systems by 2015.

France is Europe's second-largest producer of electronics after Germany, with an embedded systems and software market valued at €923 million in 2010[2].

A challenge for the future

Embedded systems alone consume up to 86% of all electronic chips manufactured worldwide. Half of all French manufacturing industry uses embedded systems. 63% of the industry's jobs are in manufacturing, 31% in computer services and 6% in software houses. This ecosystem supports seven different types of player: manufacturing industry; the equipment and systems producers (Valeo, Thales, Bosch, etc.), the research laboratories (CEA List, Inria, etc.), the competitiveness clusters (System@tic, etc.), the development partnerships (Autosar, Artemis, etc.), the service providers (Altra, Sogeti, etc.) and the software houses (Esterel Technologies, etc.). In the French context, the Paris Region is a magnet for this industry opportunity to even further improve living standards in the Paris Region.

Training: the central challenge for innovation in this sector

"*Embedded systems rely on two main areas of expertise: IT and electronics, and complex project management,*" explains Éric Lerouge, Head of the Embedded Systems business line at the digital industries association Syntec Numérique. "*There's a real lack of digital systems specialists in France, and therefore a lack of experts specializing in embedded systems. Demand is high, especially from major customers and across an increasingly-broad spectrum of applications. For example, 75% of the electronics used in an automobile are now embedded systems, and that is where the growth really lies,*" he continues. A survey of existing sectors commissioned in 2009 by the Embedded Systems Committee at Syntec Information Systems had already identified a shortfall in the numbers of embedded systems specialists relative to demand from manufacturers. In France, the training effort is striving to close that gap, and the majority of the required capability is right here in the Paris Region, which is home to the country's leading engineering graduate schools and universities.

Supélec: © Cécile Oriot de Centrale Paris

Specialist courses

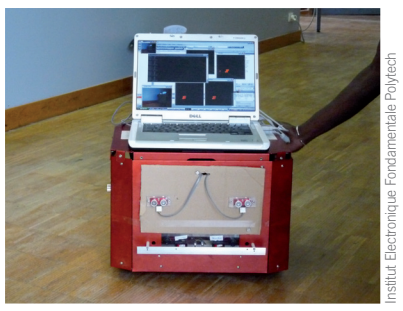
The major universities are already offering specialist courses. For example, Orsay is offering a Masters 2 specialty in Embedded Systems and Industrial IT. This advanced-level course concentrates on the design of embedded systems, industrial IT s*ystems and electronics systems. "But the students tend to be more attracted to engineering graduate schools,*" explains Arnaud Bournel, Permanent Head of the Paris Region Center of the Microelectronics Doctoral Network at the Université Paris-Sud. It's the technical training and research opportunities that attract students to the Orsay campus. "*We cater for Masters 2 level engineering graduate school students, who come to us in parallel with their engineering studies,*" continues Arnaud Bournel. The Paris Region is home to many engineering graduate schools that have developed their own specific courses over the last 10 years or so.

Engineering graduate schools lead the way

Most of these graduate schools have the advantage of networking with manufacturing industry, and many of the companies recruiting graduate – "*Thales, Valeo, PSA, EADS, Alstom, Siemens, Schneider Electric, Veolia, EDF, GDF Suez...*" – make reference to ECE Paris. The same is true of Polytechec, the engineering graduate school that forms part of the Université Paris-Sud, and benefits from access to the university's research facilities, bringing students into direct contact with the industry's largest companies via internships. The courses offered are also tailored to the needs of industry. "*It's research that allows us to do that here at Polytech,*" explains Samir Bouaziz, a lecturer in IT Engineering and Embedded Systems at Polytech Paris Sud. "*The ECE is even planning to set up its own new business start-up center in the near future,*" emphasizes Christophe Baujault, Head of the ES Major course at the ECE.

A cross-disciplinary specialty

Other graduate schools, including Supelec, offer no specific course. "*But in the third year particularly, this area of study, which cuts across the disciplines involved in our engineering courses, is the subject of many teaching modules. That's true of information technology, electronics, energy, telecommunications and control systems, where this area of technology is clearly crucial for applications in the automotive, aerospace, telecoms and other industries,*" explains Patrick Bouchez, Head of the Automation Department at Supélec. "*Learning how to work in partnership with another person and as a member of a 15-strong team is another important skill for our students to learn, because that's one of the realities of working in embedded systems,*" explains Samir Bouaziz. "*Our students develop their projects towards achieving real-world recognition in the form of publication in a scientific journal or the registration of a patent,*" emphasizes Christophe Baujault. Final-year projects can be as diverse as creating a voice-activated control system for a mobile robot or designing and producing an ID card embedded in a computer chip. At Polytech, "*our students are involved in a project to develop a flight simulator,*" continues Samir Bouaziz. All of them find jobs when they leave, because these graduate schools and university faculties achieve record-breaking placement rates.



Institut Electronique Fondamentale Polytech

In-service learning: the career trump card

In-service learning is another response to the soaring demand for specialists in embedded systems. These qualification-based courses for those already in employment supplement the traditional educational route by offering upskilling opportunities to those already partially operational in this discipline. Two professional qualification certificate courses (Certificat de Qualification Professionnelle or CQP) have been created this year, explains Syntec Numérique. The first, which focuses on embedded systems architecture, is due for introduction this September. "*For example, a technician with 15 years' experience in electronics could complement his or her existing professional expertise with a qualification-based course leading to a recognized and valuable qualification in embedded systems,*" explains Éric Lerouge. Scheduled for 2013, the second 'Inter-Sector' CQP is designed to allow eligible participants to make the transition to the various areas of embedded systems. "*So, for example, someone could make the transition from telecoms to avionics, and that sort of mobility is important for distributing expertise. We need to make students aware of the issue of embedded systems at every level. That's quite a communication challenge, but something we need to achieve from secondary education onwards,*" concludes Éric Lerouge.

All the surveys and reports agree on the importance of involving every embedded systems training and education provider in responding effectively to the needs of the coming months and years. This is an impressive and promising source of future jobs and growth.

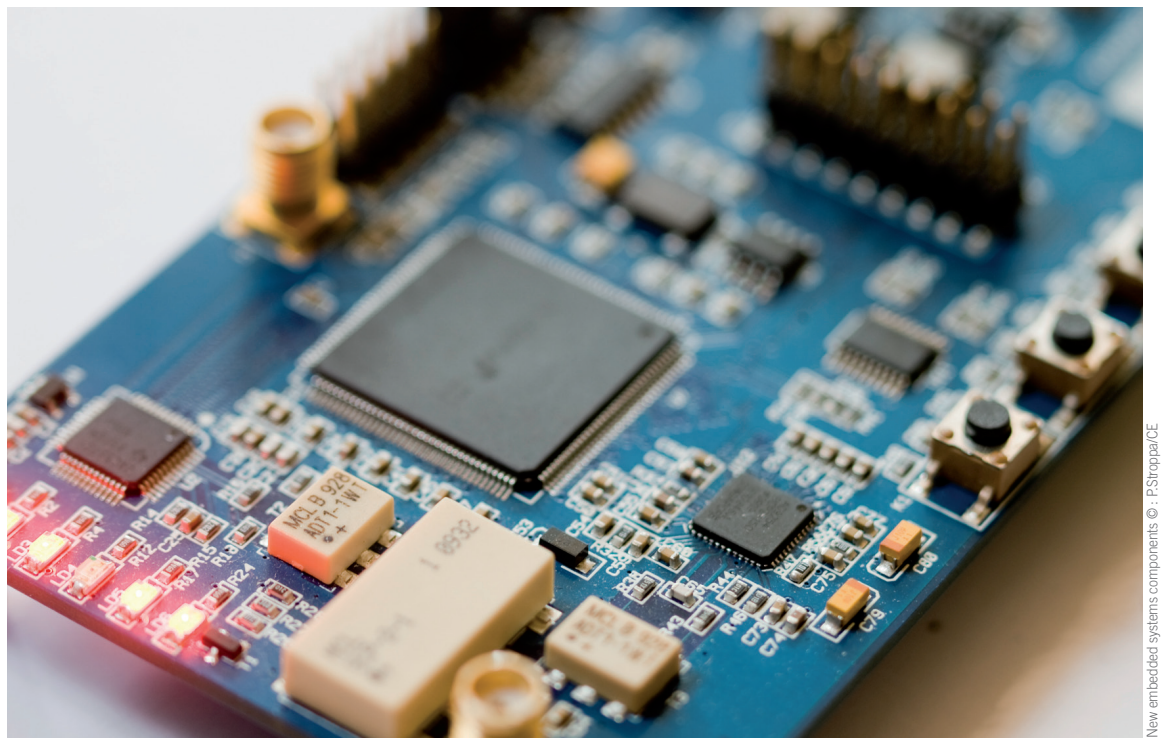
1 Intelligent Systems: The Next Big Opportunity, published by market intelligence analyst International Data Corporation.

2 Paris Region Economic Development Agency.

The heavyweights and challengers of embedded systems

LISA TELFIZIAN

The Apollo lunar lander achieved its mission with just two embedded systems, but today, even the most humble automobile contains dozens of them. The industrial companies of the Paris Region are now leading innovation in transportation, healthcare and smart devices on the basis of work done by their own in-house laboratories. Alongside these heavyweights, SMEs are winning strategic market share.



New embedded systems components © : P.Stroppa/CE

Three to six years before a new model is launched, the electronics and advanced technologies teams at Renault are already hard at work. Which embedded systems will give the company the edge in the highly competitive market to create tomorrow's automobiles? No fewer than 300 people share the responsibility of identifying emerging technologies that can be harnessed to create the innovative, real-life automotive applications of the future. *"In our business, good innovation comes out of the cross-fertilization of technology and practicality. In this team, we have specialist embedded technologies engineers working alongside ergonomists and sensory analysis specialists,"* explains Patrick Bastard, Head of Electronics and Advanced Technologies. For its pure research, Renault works with the French Atomic Energy Commission (CEA) and the Paristech and Supelec graduate schools. In the pre-competitive phase, the company may also work alongside its competitors to progress research into new semiconductors that could potentially be used in future embedded systems components. Embedded system software is a different issue, and is too brand-specific to be the subject of collaboration.

Electric vehicles are energizing embedded systems

Electric vehicle development is now an essential focus for all manufacturers. *"An electric car isn't just a standard automobile in which the gasoline engine has been replaced with an electric motor, because the entire electronic system has to be totally redesigned. For example, these vehicles recharge their batteries using energy generated during braking, but that produces no heat, so we have to design a special heating system,"* explains Patrick Bastard. The many new functions offered to drivers and passengers all rely on embedded systems technology. Zoé, the first mass-market electric automobile, regulates its own level of hygrometry[1] to avoid the excessive dryness sometimes caused by air-conditioning systems, diffuses relaxing fragrances for the drive home from work, and stimulating scents for night driving, but heats only the seat and steering wheel, since heating the entire passenger compartment would consume energy without improving the sensation of comfort.

Thinking connectivity

Automobile connectivity is also a central focus. *"The automobile is no longer a bubble of personal isolation, it's a link between home and work and a component in today's connected world. One of the challenges is to determine how connectivity should be distributed between the vehicle itself and the smart phones used by drivers and passengers"*, explains Patrick Bastard. But that thought process is not as simple as it might seem, since the system must offer a fluid and easy-to-use interface. Unlike a train driver or aircraft pilot, most regular drivers aren't professionals trained in the use of special equipment. In the end, wherever you look, from engine consumption to vehicle cleanliness and safety, very few aspects of the vehicle do not involve embedded systems.

The aerospace industry relies on safety-critical embedded software

In aviation too, embedded systems are gaining in strategic importance in the quest to achieve new performance levels. Sagem, the high-technology company of the Safran Group, the leading manufacturer and supplier of civil and military aircraft equipment, designs embedded avionics systems and missile guidance and self-seeking applications, as well as optronic[2] / thermal imaging cameras and visors. Electronic hardware and software are also increasingly embedded in engines, landing gear, braking systems and flight controls. To enhance the effectiveness of these systems, the company created a new division three years ago called Safran Electronics to act as the focus for its research and design work on embedded systems processors and software. A total of 1,200 researchers now work on developing these 'safety-critical' embedded systems. At the end of 2011, Sagem set up a joint venture with leading German engine manufacturer MTU Aero Engines: *"The embedded engine control system is a strategic issue for everyone, so we're getting together to pool what are essentially rare skills and experience,"* explains Safran Electronics General Manager Jean-Michel Hillion.

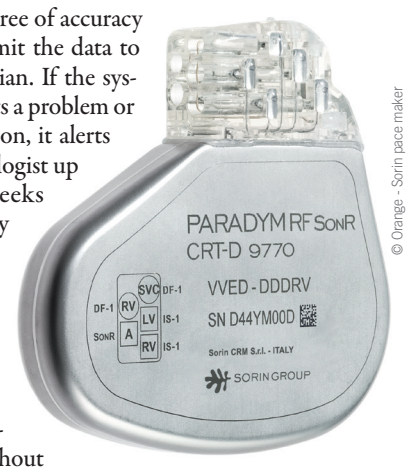
Improving aircraft safety and reliability

Today, 30% of the systems used in commercial aircraft are embedded systems; a proportion that rises to 50% for military aircraft. Whereas the aircraft of the 1980s carried several dozen on-board computers, the current generation carries several hundred, which are expected to deliver ever-greater performance for tasks like on-board Internet access, engine fuel economy and shorter braking distances. With aircraft, the focus is always on greater safety and operational availability, so embedded systems are increasingly essential. *"An A320 must be able to fly for 70,000 hours without downtime. That's only possible because of our continual work on computer reliability and the development of the increasingly-sophisticated digital embedded systems that maintain and monitor the operation of all the other embedded systems in the aircraft,"* explains Jean-Michel Hillion.

The move to electrical controls also improves the quality of aircraft onboard systems, because it reduces the number of hydraulic circuits, which are susceptible to leakage and contamination, and increases the space available for passengers, because electrical systems take up less room. Embedded digital technology is changing the flying experience for pilots and passengers, at the same time as improving safety and airline profitability.

Better healthcare thanks to embedded technologies

Embedded systems are also preparing to revolutionize the world of healthcare. Yet to appear fully on most people's radar, Orange Healthcare is developing a remote monitoring solution for cardiac patients. *"Conducted in partnership with cardiac rhythm management devices manufacturer Sorin, this project is making excellent progress. We're currently in the preclinical test phase, and we expect patients to be able to benefit directly from this new connected cardiac implant this summer,"* explains Orange Healthcare Marketing Director Lyse Brillouet. 3-D sensors embedded in the patient's pacemaker device monitor the heart to a high degree of accuracy and transmit the data to the physician. If the system detects a problem or deterioration, it alerts the cardiologist up to two weeks before any symptoms become apparent, and the data held in the unit can be analyzed without the need for the patient to be admitted to hospital. The potential healthcare applications for this type of technology seem almost endless. *"We've recently won the contract for a very exciting project to digitize medical imaging data for the entire Paris Region, which will involve scanning x-rays so that they can be shared between hospitals, patients and physicians,"* explains Lyse Brillouet. *"We see these regional digital resources as a key challenge and an essential building block in the process of encouraging medical professionals to cooperate in new ways."* As a result of digital and embedded technologies, hospitals will be able to reach out and deliver care to patients in their own homes, improving the standard of healthcare, at the same time as reducing costs. innovation. And similar initiatives are springing up all over the market. This is proof that, in the near future, sustainable construction won't stop at the building frame; instead, it will be part of a comprehensive land use planning approach. And, no doubt, the Paris Region will be on the leading edge of this effort.



© Orange - Sorin pace maker

SMEs that are revolutionizing and inventing the future

SMEs and startups are also driving innovation in the Paris Region. For the past 10 years, a VSE called Pragmadev and its six employees have been winning contracts all over the world. *"Alcatel is using our Real Time Studio suite of real-time and embedded application development tools in the USA, Canada and China,"* explains Pragmadev Director and Founder Emmanuel Gaudin. Airbus (EADS), Renault and the European Space Agency are all on the client list of this very small Paris Region business winning the battle against international competitors in this segment of the market. Magillem, the company famous for software platforms that improve the process of designing complex content integration systems, signed a multi-year collaboration agreement with the French Atomic Energy Commission (CEA) in February 2011. The project focuses on the development of SoC (System on Chip) software tools designed to improve the checking of embedded systems; a critical and strategically important phase for systems designers.

With this dynamic community of major companies and small businesses, the Paris Region is attracting new innovators all the time: the German company IXXAT has chosen the region to set up a company specifically to conquer the French market for the CAN (Controller Area Network) technology used to exchange data between embedded systems in a single industrial product. BMW already uses some of its applications. *"BMW chose our CAN / FlexRay cards and RBS simulator to test the embedded system that allows the engine to communicate with other computers and components in its 7-series range,"* explains Sales Director Frédéric Astier. Philips Medical Systems has also adopted IXXAT CANopen technology for its radiology equipment, because this protocol cuts costs by reducing the amount of electrical wiring required.

3D Plus has built itself a global reputation in just 15 years, thanks to a technology covered by no fewer than 25 patents. *"Our ability to miniaturize electronic components and chips allows us to work for customers in the space industry, and more specifically on satellite embedded systems. But we also operate in medical markets and are working on prototypes for heart pacemakers so small that they can be incorporated into the heart itself,"* explains Christian Val, the Founder of de 3D Plus, which currently employs 110 people. Several of the company's projects focus on Structural Health Monitoring, in which miniscule sensors provide permanent monitoring of engineering structures, such as tower blocks and bridges. The company has recently been acquired by the US aircraft industry group Hélico, but will remain a 100% French business based in the Paris Region. All of which demonstrates how small embedded technology companies can become big hitters very quickly...

[1] **Hygrometry** is the measurement of humidity in the air.

[2] **Optronics** technology combines optical and electronic functionality to create devices that usually incorporate an optical sensor, an image processing system and display or data storage system (source: Wikipedia).

Research and innovation: a key issue for embedded systems

When it comes to embedded systems, research and development capability and a dynamic approach to innovation are key issues. It's a sector in which the Paris Region plays a particularly active role through its competitiveness clusters and dozens of research laboratories.

SOPHIE MIGNARD

Traditionally well-served in terms of research and innovation, the Paris Region is equally involved in the world of embedded systems. In terms of software, the *"Briques génériques du logiciel embarqué"* (Generic building blocks for embedded software) report produced by Dominique Potier, Head of Research and Technology at Systematic Paris-Region, reveals that the Paris Region is particularly active in this field. Here's what the report has to say: *"The geographic distribution of embedded software R&D was charted on the basis of analyzing 24 of the embedded software projects included in the ARPEGE program. This program has been in place for several years, and the great majority of embedded software developers with their own Research and Technology (R&T) functions are members. It is therefore reasonable to suppose that the data for this program provide an accurate indicator of the intensity of R&T activity focused on embedded software at regional level, particularly in terms of publicly-funded laboratories."* On this basis, it seems that in terms of contribution, the most active regional concentration is the Paris Region (37%), followed by Rhône-Alpes (16%), Brittany and Pays-de-Loire (14%). So with competitiveness clusters, research laboratories and networking between researchers, it would seem that the Paris Region has a particularly rich and diverse share of embedded systems research and innovation. Its competitiveness clusters are particularly active in this field.

Systematic Paris-Region

The Systematic Paris-Region cluster has around 650 members, including 362 SMEs, 132 major companies, 27 midsize businesses, 102 research centers and educational institutions, 19 regional and local authorities and 15 investors. The purpose of this competitiveness cluster in the south-west of the region is to develop key tools and technologies for software systems, whilst focusing its work on technology application markets. This positioning cuts across application and technologies markets, and is the reason behind the cluster's organizational structure of six groupings: automotive & transportation, smart energy management, open source software, systems design and development tools, digital trust & security, and telecoms. *"In all these areas, one of the main priorities is the design of operationally-stable embedded systems, and therefore the development of software methods and tools that will ensure that these systems meet the required reliability and security standards,"* emphasizes Dominique Potier. *"At the same time, more and more embedded functions require intensive processing, so we're also developing processor architectures that deliver very high computing power."* These new-generation chips will eventually provide automobiles with advanced safety features, like immediate environment perception (detection of obstacles, etc.), and the ability to create structural monitoring systems for critical infrastructures. Many projects are therefore now being developed by Systematic Paris-Region members. In transportation, cluster teams are working on the AUTOSAR standard for embedded electronics to develop the skills and technologies required by automotive component manufacturers to ensure compliance with this demanding standard crucial to the future of the industry. Other projects are underway on control and command systems for energy applications and in healthcare, with connected medical implants, remote treatment systems and home medical supervision.

Multiple projects are often co-funded by a number of different public-sector players, from the Paris Regional Council to other regional and local government authorities, all of which are stakeholders in the governance of Systematic Paris-Region. Across all its areas of activity, Systematic Paris-Region has so far enabled the development of 329 collaborative R&D projects, representing an overall R&D commitment of €1.5 billion and total funding of nearly €550 million.

View of RAFALE cockpit © Dassault Aviation - Alex Parringaux

ASTech Paris Region

The ASTech Paris Region competitiveness cluster looms very large in the world of aviation, since it covers the country's largest employment catchment area of jobs in aerospace and embedded systems, employing more than 100,000 people and accounting for the majority of R&D jobs in this sector of French industry. Structured into seven specialist areas, its technology goals are focused on designing more eco-friendly aircraft. This work essentially involves reducing aircraft weight, fuel consumption, noise and all the associated unwanted side-effects, such as emissions of carbon dioxide and nitrogen oxides. In practical terms, achieving these goals requires the increasing use of electrically-powered equipment, more extensive use of composite materials in airframes and cleaner engines, all with the aim of delivering greater reliability and lower costs.

ASTech is home to many projects involving embedded systems. *"In embedded energy sources, the SEFORA project aims to optimize the operation of electromechanical actuators in extreme environments,"* says Jean-Marc Le Peuvedic, Head of Embedded Energy Sources at ASTech. *"The CISACS (Innovative Concept for Secondary Flight Control Actuating Systems and Ancillaries) project, on the other hand, is developing shared power electronics systems that serve multiple functions in order to reduce the overall weight carried by aircraft."* The THERMELEC (THERmal Management for embedded power ELECtronics devices) aims to develop and validate innovative solutions for the localized transfer of heat in hostile environments (hostile in terms of temperature, vibration, pressure, etc.). So all the technologies researched as part of THERMELEC share the common goal of increasing the reliability and resilience of power electronic components for tomorrow's more electric aircraft, at the same time as reducing their weight.

The Vehicle and Equipment Architecture section of the cluster is concerned with development and qualification methods, the integration of embedded equipment and technology step changes with implications for vehicle architecture. *"We aren't involved in the design and development of new equipment, but rather in systems integration for aircraft and UAVs,"* explains Claude Tribout, who heads up this section of the competitiveness cluster. *"For example, we're working on autonomous decision-making with the aim of creating aircraft that are more intelligent by using new communication systems and data analysis architectures. In practical terms, it may find applications in an unmanned aerial vehicle used to monitor a national park, introducing the ability for the aircraft to change the area it monitors without the involvement of a ground-based operator. We're also interested in the intelligent cockpit concept, which would enable airline pilots to be informed of the precise moment when a risk becomes unacceptable and a decision has to be made."*

Mov'eo

Based in the Paris Region, Lower Normandy and Upper Normandy, the Mov'eo competitiveness cluster for the automotive and public transportation technologies includes 75 major companies, 159 SMEs, 50 research and training centers, 21 public and private institutions, 7 regional and local authorities, and 5 ex-officio members. Since its inception in 2006, Mov'eo has sponsored and accredited 262 R&D projects, 130 of which have received public subsidies totaling €216 million. The cluster is structured into the seven sectors of: smart mobility solutions, road user safety, zero-carbon demonstrators and vehicles, vehicle environmental footprint, energy storage systems, mechatronics systems and internal combustion drivetrains. *"Many of the projects in place in all these sectors make use of smart systems to enable vehicle components to carry out mechanical operation on the basis of autonomous decision-making,"* explains Nicolas Dattez, Head of Mecatronic and Energy Storage System Projects. *"Today's automobiles are beginning to resemble computer networks on four wheels, and mechatronics is making it possible to introduce increasing numbers of smart mechanical systems. This requires the development of embedded systems suited to coping with the multiple physical stresses imposed by vibration, heat, sealing and electromagnetic compatibility (EMC) between systems. Another of our aims is to develop and perfect embedded systems that are reliable, small, very lightweight and use very little electricity, so we're working on new components, new technologies and new design methods to achieve those outcomes."*

AUDACE (Analysis of the causes of component failure in embedded mechatronic systems) is one of the exciting projects underway in this cluster. Its aim is to create a clearer understanding of fault mechanisms and offer innovative solutions to deliver the levels of quality and competitiveness vital for ensuring the success of future generations of electronic and mechatronic systems. The COMPACITÉ (Compact power-efficient electric air-conditioning compressor for hybrid and electric vehicles) project, on the other hand, is working on the application of a new mechatronics-based approach to the design and production of the electric compressors needed to provide air conditioning in electric vehicles.

CEA LIST Institute

Within the competitiveness clusters, prestigious research laboratories make their innovative skills available directly to industry. The CEA LIST Institute forms part of the Systematic cluster, and describes itself as 'Serving industry through open innovation'. This technology research center for smart digital systems is structured around three key areas presenting significant social and economic challenges: embedded systems (multiprocessor architectures, embedded system security and reliability, software and systems engineering), interactive systems (interactive robotics, virtual reality, sensory, visual and multimedia interfaces and communicating systems) and sensors and signal processing (innovative sensors, metrics systems, data analysis, nondestructive testing and metrology of ionizing radiation).

"In overall terms, the 750 people here at CEA LIST work mainly on digital technologies for industrial applications," explains CEA LIST Institute Director Riadh Cammoun. *"We use a joint innovation model in conjunction with our industry partners, and try to identify where our technologies can deliver real value and introduce a step change that will transform current practice. In transportation, for example, we began with digitizing Airbus flight controls. Today, these technologies are being introduced very rapidly to the automotive and rail industries. Similarly, improvements in software security - a major challenge for embedded systems - were originally developed for the control systems of nuclear power plants, but were then applied to control systems for industrial machinery, aircraft and automobiles. Depending on market maturity, we can therefore help certain sectors of industry to make the transition to new technologies by introducing technologies originally developed for other sectors. So it would be true to say that our goal is to develop a generic technology that we can then introduce to a number of different markets for application."*

Training platform for maxillofacial surgery C.Dupont/CEA

Achieving that goal has its roots in a very wide-ranging partnership with industry and other research institutes. In fact, CEA LIST has set up a joint laboratory with Esterel Technologies, an SME specializing in development tools for safety-critical embedded systems, where half of the 120 staff work in research. The company uses this new laboratory - called Listerel - to develop products for systems modeling; one of the areas of expertise specific to CEA LIST. Continued on page 4 >

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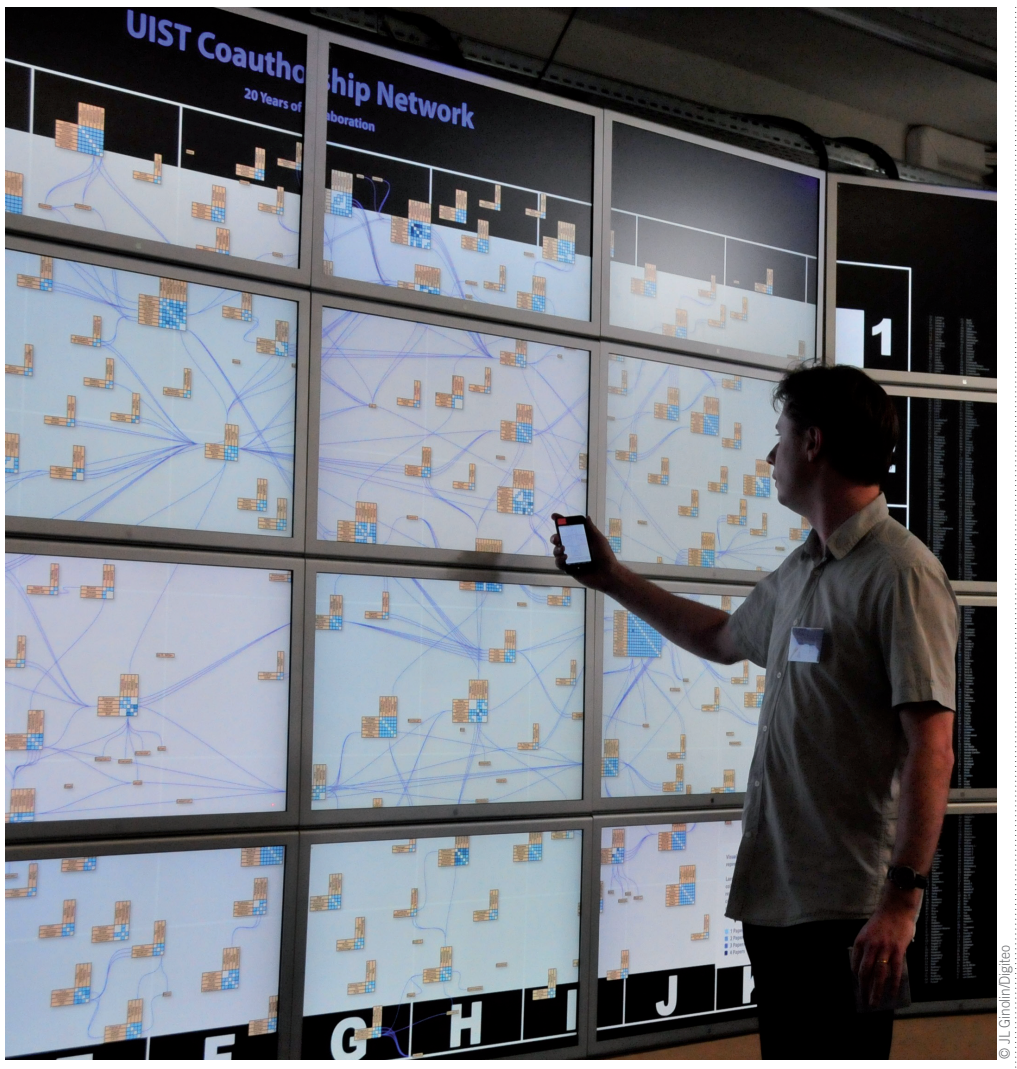
Digiteo

As the creation of Digiteo clearly demonstrates, research in embedded systems is also able to rely on consistent support from the Regional Council and the Essonne General Council. This network for advanced research was formed in 2006 by the CEA (the French Atomic Energy Commission), the CNRS (the French National Science Research Center), the École Polytechnique, Inria, Supélec and the Université de Paris-Sud 11. These founder members have since been joined by six associate members: ENS Cachan, the École Centrale Paris, the Université de Versailles Saint-Quentin-en-Yvelines, the Institut Télécom, ENSTA ParisTech (the National Graduate School for Advanced Technologies) and Mines ParisTech.

"The intention of the founder members was to create a coherent framework in which to extend their researches into the information and communication sciences and technologies, and to work together on the economic impact of their research findings", explains Digiteo Director Maurice Robin. The project came with substantial infrastructure needs, in response to which the Paris Region provided very significant funding (of €24 million) in conjunction with the Essonne General Council and the Saclay Plateau urban community. As a result, Digiteo now occupies new premises on three sites at Saclay, Moulon and Palaiseau, where the majority of the research laboratories operated by its founders and associates will eventually be located, employing around 2,600 scientists, including 1,000 doctoral students. The funding provided has also been used for projects in the major research focus of complex software and systems introduced by the region for the period 2007 to 2011, which attracted total funding of €33.218 million (which included funding for building construction) and subsidies for specific projects developed by competitiveness clusters.

As a key player in publicly-funded research within the Systematic Paris Region competitiveness cluster, Digiteo specializes in the design and development of predominantly software systems. The majority of research conducted within the network focuses on software (from fundamentals to engineering), modeling and simulation, computing architectures, sensors and detection systems, control, command and decision support systems, and interaction, visualization and virtual reality. But research also extends to crossover disciplines, such as robotics, bioinformatics, hybrid systems and future networks. *"The teams at Digiteo are working on many different projects with implications for embedded systems",* continues Maurice Robin. *"For example, work is currently being done on embedded image processing for shape recognition, as well as program security verification and mobile sensor data analysis."*



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Inria

In addition to shared programs, the teams working in each research center also conduct their own specific projects. For example, Inria is currently running a number of research projects involving embedded systems. *"Of the 171 project teams at Inria, 44 - that's more than 1,000 people - are working on embedded systems,"* stresses Thierry Vareine, Head of Technology Transfer at Inria. *"When you include the teams working on associated areas, such as smartcards and telecoms, you arrive at a very considerable number of researchers working in this field."* Some teams work in bilateral partnership with companies. *"Our aim is to put together bilateral partnerships as a way of developing innovation inside these partner companies,"* continues Thierry Vareine. *"The support provided by Inria makes it possible for these innovations to feed through into the market, thereby creating jobs. The applications involved are not only safety-critical systems for aircraft, automobiles and rail systems, but also - and increasingly - consumer applications in smart phones and home automation."*

Welcome to Paris Region

In 2010, the Paris Region, the leading French region in terms of incoming foreign businesses welcomed 243 foreign companies, up an outstanding 27%. This new production potential will generate over 8,400 jobs in the next three years, which also puts the Paris Region ahead of its French counterparts.
Created at the initiative of the Regional Council for the Paris Region, the Agency offers free and completely confidential services to companies locating and growing their businesses in the Paris Region.
You want to grow a new business in Europe: we conduct a tailored opportunity survey on your behalf to provide you with straightforward, practical feedback on technology and market opportunities offered by the Paris Region and also on the economic environment of the Paris Region.
You want to locate successfully in the Paris Region: we support you at every stage, with assistance from our specialist partners in matter of real estate, recruitment, legal and tax issues, commercial, technological and financial partnerships, international mobility, environmental management and communication.
You want to increase your presence in the Paris Region:
You are looking for new premises; you are expanding your team and need to recruit new skills; you are planning to develop R&D facilities here: we are here to support your expansion in the Paris Region.
The Annual PREDA International Companies Forum brings you into direct contact with the largest multinationals of the Paris Region and the partners of the PREDA.
An entire team is at your disposal: **Technical experts** in human resources, real estate, legal and tax issues, international mobility and environmental management and **Market experts** in aerospace and air transportation, automotive, cosmetics, eco-business, electronics, IT software, IT multimedia, logistics, life sciences and financial services.

For more information:
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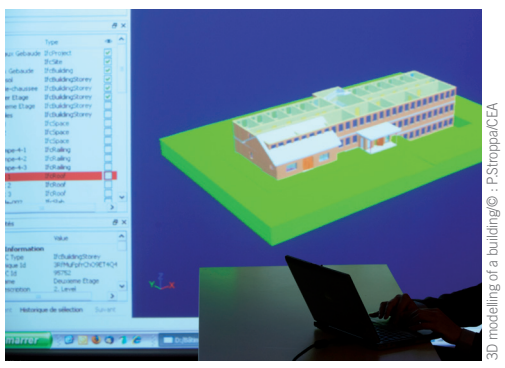
An industry in the making


3D modelling of a building/© : P.Stroppa/CEA

For many years confined within specific business sectors, the market for embedded systems is gradually emerging and gaining ground. The innovative capabilities of those involved in this market will therefore be a determining factor for the future competitiveness of companies.

The future for embedded systems looks dynamic, to say the least, as this once-niche activity exclusive to specific applications spreads into the majority of industrial processes and products.

"Until now, the world of embedded systems was restricted essentially to transportation, aerospace, the automotive industry and medicine," says Thierry Vareine. *"All these areas require extremely reliable products, because the consequences of failure can be grave in terms of human life. These are safety-critical embedded systems, which are increasingly referred to as real-time critical systems capable of providing instant management of any system failure. At the same time, many types of embedded system are now becoming part of our daily lives in the form of smartcards, mobile phones and set-top boxes, and all these products have their own constraints in terms of size or energy consumption, for example."*

"The market for embedded systems is growing all the time", adds Eric Bantegnie, Founder and CEO of Esterel Technologies. "It's being driven essentially by demand for mobility and new sources of energy. We're also seeing a constant stream of new applications for use in buildings, lighting and rail systems."

And the opportunities for growth over the coming years are very significant indeed. *"We believe that there are many gains and step changes to be identified beyond the boundaries of today's disciplines,"* takes up Riadh Cammoun. *"For example, we are interested in exploring the boundary between hardware and software and human/system interaction. Growth will come from the ability to leave behind the major industrial silos of the past - in energy, for example - in order to develop products that enable consumers to become generators themselves".*

Applications in all sectors of industry

"Only 10 years ago, embedded systems were a highly specialized niche market exclusive to aerospace and safety systems," continues Dominique Potier. *"Today, they are becoming a digital component as important as enterprise resource planning systems and Internet data search and management systems. They provide a crucial link between information systems and the physical world. In this way, a vehicle may be connected to the road infrastructure, traffic management systems and other vehicles. Similarly, the individual components of a home, its security, the services it provides for the comfort of its occupants, and their work and leisure activities will be integrated seamlessly and managed both locally and remotely. Lastly, we will soon see the emergence of a very broad range of applications in the form of services and support for day-to-day living, including medical and social services."* The scope of application for embedded systems is growing continuously, and a policy of innovation that involves research and industry will enable companies to remain competitive within their core business activities.

Investing in the Future

As part of extending the conclusions arrivedatbyDominiquePotier'smission, the French government announced the *"Generic Building Blocks for Embedded Software"* call for projects on December 8, 2010 as part of its Investing in the Future program.

Sixteen Research and Development projects were submitted, of which six have been adopted, and will receive public funding of €32 million towards total research and development costs of €72 million.

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